SCIENCE

NEW YORK, OCTOBER 23, 1891.

GOVERNMENTAL SCIENCE AND THE CIVIL SERVICE.

THE visitor to Washington who has been acquainted with its life and appearance in the past notices many striking changes for the better that have taken place within the last ten years. Perhaps none of these make more lasting impressions on him than those which are brought about by the great alterations affecting the official life of the city, which are due to what are generically termed civil service reforms. The dweller in a Washington boarding-house or small hotel — and these are *sui generis* in the *personnel* of their inhabitants — sees far less of the feverish uncertainty, constant fear of the departmental headsman, and hesitancy in claiming the possession of one's own soul, than was to be observed a decade ago. To the civil service acts passed by Congress since 1882, the promptness in putting their requirements into force shown by Presidents Cleveland and Harrison, and the efficiency of the commissioners having this branch of the public service in special charge, is to be attributed the present condition of this reform — for reform it undoubtedly is.

In their report for 1889 the commissioners say, "The merit system of making appointments to minor government positions, as contrasted with the patronage system, whereby appointments were made as rewards of personal or political services, is no longer in the merely experimental stage." What was true in 1889 must be doubly so in 1891. It is but fair, then, to point out wherein certain customs and rulings of the commissioners are still unjust to the entire people, and have a pernicious effect on important branches of the public service. The nature of these defects can best be pointed out after quoting further from the report of the commissioners. They say: "Examinations are held for scores of different places; and for each place appropriate tests are provided. Thus it is necessary for an assistant chemist to know something of chemistry, and for an assistant astronomer to know something of astronomy. . . . There is an impression abroad that those who take examinations at Washington have some advantage over those who take them elsewhere. There seem to be some good grounds for it with regard to the special examinations. This is probably due to the fact that very many of those who are examined here have better opportunities than those living elsewhere for acquiring a knowledge of those technical subjects which are required by the different departments."

As an illustration of how this may work, let me cite the following case. A few weeks ago a position was vacated in one of the divisions of the Agricultural Department, and announcement of the fact that an examination would soon be held for such a vacancy, requiring "a person understanding botany, Latin, and Greek," was made in the daily press of the city. This announcement, according to the custom of many local papers throughout the Union, found its way into the home of a trained botanist and linguist in one of our southern States. This he mailed at once to a friend with the request that he would ascertain for him when, where, and how the proposed examination was to be held. Imagine this friend's surprise when, on application for this information at the office of the Civil Service Commission, he was informed that the position was already filled, the examination having been held two days before. Yet his correspondent, who lived less than a thousand miles from Washington, had written him at once on receipt of the announcement, and the local weekly paper could not have sooner inserted the information found in the dailies. Further conversation with the officer to whom he was referred at the office of the commission, and inquiry at the Department of Agriculture, elicited the following facts. If a vacancy is to be filled, the Civil Service Commission gives ten days notice of the special examination therefor. If a person living outside of Washington wants to be examined for the vacancy he must write to the commissioners, preferring his request, and a special examination will be held for him at some place designated by them, the capital of the State usually being the place selected. In this particular case the vacancy was undoubtedly creditably filled; though the appointment of the southern resident, who only heard of the vacancy the day that it was filled, would have shed far more lustre on the department, as he outranked in scholarly and scientific attainments most of those with whom he would have thus been brought in contact.

In the ordinary offices, such as those of clerks, copyists, stenographers, pension examiners, railway-mail clerks, letter carriers, etc., the applicants far outnumber the needs of those respective branches of the service, as is shown by the fact that, while in 1887 the entire number of offices under the custody of the commission was 28,000, they were called upon to examine over 20,000 applicants for the vacancies in those ranks. So it is the fact that in these grades the existing rules act admirably and tend to the continual elevation of the public service. But in such positions as those of examiners of the Patent Office, and technical and scientific experts in the various departments, the present system is very imperfect, inasmuch as it is hardly possible that any considerable portion of the scientific and technical skill of the country is in Washington seeking a position. Surely a very respectable majority of such talent must be in cities far removed from the national capital, and any system which practically rules out all the regions not within a few hours' ride of Washington is abortive, and degrading of the general standing of scientific officialdom.

If such positions as have been indicated are to be filled under the laws governing the Civil Service Commission, then the commissioners should at once put into force rules that would do away with this very evident local favoritism, and which would enable the practical geologist in southern California to compete on fair terms with the recently graduated youths from the Columbian and Johns Hopkins Universities. It is quite as practicable that printed announcements of such vacancies should be posted in every post office in the country as it is that they should receive the daily weather bulletins. And no examination should be held until the resident of the most remote corner of the West had had ample time to apply to the commission for a special ex-

amination in his locality, and such a local special examination should never be held in a more remote place than the county-seat of the county where the person to be examined resides. There can be no reason why the paper containing the examination questions may not be safely mailed to the postmaster, the seals not to be broken save in the presence of all of a board of three, to consist of the postmaster, a prominent professional man of the town, and a notary public. Before these the applicant could appear, and in their presence answer the questions sent to them. To the facts of the regularity of the examination they could swear, returning the affidavits and the applicant's answers to the commission. As these special examinations are infrequent, and the positions for which they are held are of considerable importance, and should be filled by the best men at the disposal of the government, no plea of extra expense, of unnecessary trouble, nor of danger of collusion should be heeded. The latter danger would be practically *nil;* it is inconceivable that three prominent men, not more than two of whom should be of the same political party, would jeopardize their positions and reputations in their communities by any form of collusion. If these positions are not worthy of this small extra outlay of time, patience, and cash by the commission, they are confessedly not worth filling at all. The present plan contributes to a degree of departmental degeneracy and the continued existence of certain hangers-on, the relics of the departing age of political preferment, which should no longer be tolerated. At present it is quite as likely to be the ne'er-do-well friend of some clerk in the bureau where the vacancy is about to occur, who, getting an early hint of the coming vacancy, rushes to one of the schools where cramming for these examinations is given special attention, as it is to be a trained expert from New England, the South, or the West.

These suggestions have been based on the supposition that the present laws selecting the offices that shall be open to the control of the commission will remain substantially as at present. The outsider, who feels only an interest in the improvement of official science as it is to be met in the capital, will be quite likely to agree with me that at present the examination regulations are attached to the wrong end of the machine. It is the heads of bureaus, and not the more obscure officials, whose offices should depend on these examinations. What matters it whether the stenographer of a bureau be an expert in his profession if the chief whom he is under dictates to him letters which plainly attest the fact that he is holding his position by virtue of political favoritism and has not yet become acquainted with the intricacies or the science of his office? So long as the head of a scientific division of a department may be chosen without reference to his eminent fitness for the discharge of his duties, it is but a pitiable farce that leads to such care being taken to provide him with competent men to transact work which he cannot direct and of which he is not a judge. If the chiefs were chosen after a searching examination into their position among their fellows in the science, the knowledge of which they were called upon to display, it might be found then that the government had thereby obtained the services of a class of men who could be trusted to choose their own underlings. I believe that this can be now said of most of these heads of divisions and bureaus, yet one is compelled to admit at times the justice of the slurs at the work done under these that the American must be prepared to hear from the lips of foreigners. There is undoubtedly yet a taint of cheapness and unworthy show about much of this work, for which the half-pay salaries allowed by Congress and the imperfect system of examination now in vogue, as here indicated, are mainly responsible.

EUGENE MURRAY AARON.

INDICATIONS OF EVOLUTION IN LEAVES.

As evolution is the eternal plan of unfolding, in the past, from nebulous matter to plant and animal life, it is absurd to suppose the same principle of progression will not continue to produce changes in the whole realm of being in all time to come.

The investigator puts his finger on the long past geologic ages and says, "These forms are all that existed at this time:" then he points out the advance of later times, and says, "This is evolution." But how this almost infinite change has been brought about, even the imagination constructs no definite plan. It is only by studying the evolution of the present that we can appreciate the changes of the past. To say that things are unchangeable is to ignore the truths of evolution. There is an ever on flowing, rising tide which bears all things on its bosom, unfolding higher conditions, and, as a result, more perfect forms and qualities.

The leaves of plants offer to the evolutionist perhaps one of the best opportunities for studying the principle of progression actually at work; producing changes in the forms of leaves, their mode of individualization, and numerical increase.

My attention was first attracted to the interesting study of variation in leaves by the Ampelopsis quinquefolia. As its name implies, it has five leaflets. Close observation, however, discerned leaves bearing seven leaflets. Sometimes the two lower leaflets were more or less notched or deeply lobed; continued search revealed various degrees of variation, from three to seven leaflets. These specimens were considered "abnormal," "freaks of nature," or "monstrosities,"—interesting because unusual. I soon observed that the Ampelopsis was not alone in its manifest variation from typical forms. On the contrary, plants quite commonly exhibit the same tendency. Rubus villosus is especially conspicuous in this respect. It has commonly from three to five leaflets, but very often the trifoliate leaves are notched and lobed as in the Ampelopsis.

Could it be that these different forms, these variations from the common type, were evidences of evolution in leaves? Can a series of leaves be found illustrating successive stages of variation, was the query which arose in my mind. The leaves of Ampelopsis quinquefolia were again examined, in all the neighboring region. They had given rise to the query, and should therefore have the first opportunity of rendering a verdict. As the search continued, these odd forms, these "monstrosities," seemed to arrange themselves in regular order, like crystals marching into line. Instead of being "freaks of nature," they now stood like many ballots in favor of evolution.

Starting with the ordinary leaf of Ampelopsis quinquefolia, numbering five leaves, the progressive stages, until it numbers seven, were found repeatedly, perhaps a hundred specimens, from a single vine of luxuriant growth.

The first transition step apparently seemed to be but a slight enlargement or fulness on the lower or outer portion of the leaflets near the base; this fulness increases until quite a conspicuous bulge is formed. A slight notch may be next observed, which deepens as the series progresses until the lobe is cut entirely from the leaflet, becoming itself a new, perfectly formed leaflet. A prominent vein is found extend-

ing from the base of the mid-rib, through the overgrown or enlarged portion, to the extreme margin. This vein, later on in the series, forms the mid-rib of the added leaflet. The variation in the blackberry leaves emphasizes this interpretation. The trifoliate leaves seem to be struggling towards the higher type represented by the five leaflets. This is seen so plainly and so commonly that it is the exception when a blackberry bush is found whose leaves do not illustrate various transition stages of division.

Potentilla Canadensis, common cinque-foil or five-finger, furnishes an extremely interesting illustration of various transition forms. It is an embryonic history of evolution in itself, which any one may read who observes it closely.

Examples might be multiplied *ad libitum*, for plants everywhere, both in cultivation and wild, repeat the same story over and over again.

The mode of division in pinnate leaves differs from that just described in palmate leaves. In all pinnate leaves which have been observed, with one exception, the newly formed leaflets were given off from the terminal leaflet. The latter will often be found unsymmetrical or lopsided, occasioned by the extra fulness produced by this evolutionary tendency towards division. The vein which is destined to become the mid rib of the future leaflet becomes prominent, and the outline of the unborn leaflet, as it were, may be plainly seen ere the division has proceeded beyond a slight notch.

After a new leaflet has been given off, there seems to have been a portion of the parent leaflet cut away; and if the new leaflet be held close against this curved or cut portion, it will be found that it corresponds with the outline of the new leaflet. The opposite side of the parent leaflet will now be found to be the larger, and the burden of adding the next leaflet lies with it: after a leaflet has been given off from each side the terminal leaflet may again become symmetrical until a repetition of the process first described again takes place. Tecoma radicans, Sambucus Canadensis, Ailanthus, are familiar examples of this plan of division.

The development of bi-pinnate and tri-pinnate from the simple pinnate leaves was also observed frequently; especially was this noted in the leaves of Sambucus Canadensis. In this case the new leaflets are given off from the oldest leaflet, or that nearest the base, first on one side, then on the other, preserving the symmetry with such precision that one is awed by the beauty and harmony resulting from the workings of vegetative forces.

As stated above, there proved to be one exception to the general plan of division among pinnate leaves. This exception was found in the leaves of the rose. Search for transition stages was made again and again in vain, when one day, while examining the leaves, more from force of habit than with the hope of finding anything bearing on the subject of variation, the mystery was cleared away.

At the base of the rose leaf two adnate stipules are found, and these stipules themselves may be called the little mother-leaves, for the leaflets of the rose appear to have been developed from the stipules. Specimens were found where the "promise and potency" of the future leaf yet existed in the stipules, awaiting, as it were, the magic touch of evolution. The upper part of the stipule becomes enlarged and leaflike, taking on more and more the shape and size of the normal leaflet, until a perfect one is formed. A graduated and progressive series was frequently found, showing various stages of transition, from the stipules alone to the mature leaf, consisting of seven or more leaflets. The new leaflets may be readily discerned before they are given off or separated from the stipules.

The petiole lengthens as the leaflets are added, thus making room for the newcomers. If a rose-leaf is examined, the leaflets near the base will sometimes be found to be more or less alternate, but becoming opposite in the direction of the apex. This may be explained by the manner in which the leaflets are developed, viz., alternately.

The tendency in leaves to divide is manifested by many simple leaves. Very often on plants bearing lobed leaves, deeply lobed or cleft ones are found; and again, on those plants where entire leaves obtain, more or less notched or lobed ones often occur.

An increased leaf-surface implies a larger amount of elaborated plant food, and consequently an increased product, either in rapidity of growth, beauty of bloom, quantity or quality of fruit. Spencer says, "Every change of form implies change of structure; and with change of form and structure comes change of function or quality." The same laws of development are seen in the study of leaves as in the social world. Heredity gives the direction in the bud or germ, and the conditions or education unfolds it. If the season is favorable, the leaf takes a pre-impressed direction of growth, and surpasses its neighbors in assuming new forms, and the average is passed; while unfavorable conditions may produce a degradation, or appeal only to the lower states of development. It will be understood, therefore, that I do not mean to convey the idea that leaves undergo this evolutionary division during a single season. On the contrary, the principles of "natural selection" and "the survival of the fittest" have left their impress upon the animal and vegetable kingdom alike. Slowly but surely heredity transmits the gain through good conditions to succeeding generations. Through the long ages of the past this process has been going on; each generation has passed on the improvements it received from its ancestry, and has added its own gain for the advance of its posterity. Each generation comes forth with renewed powers to unfold in some special direction, and I have endeavored to show, in a few cases, the plan followed in the evolution of leaves.

MRS. W. A. KELLERMAN.

NOTES AND NEWS.

THE ninth congress of the American Ornithologists' Union will convene in New York City on Tuesday, Nov. 17, 1891, at 11 A.M. The meetings will be held at the American Museum of Natural History, Central Park (77th Street and 8th Avenue). The presentation of ornithological papers will form a prominent feature of the meetings, and members are earnestly requested to contribute, and to notify the secretary in advance as to the titles of their communications, so that a programme for each day may be prepared.

— Mr. Michael E. Sadler, the secretary of the Oxford University Extension, has accepted the invitation of the American Society for the Extension of University Teaching to lecture under its auspices in December and January of the coming winter.

— Mr. Halford J. Mackinder, reader in geography to the University of Oxford, and staff lecturer to the Oxford University Extension, comes to Philadelphia next March to lecture under the auspices of the American Society for the Extension of University Teaching, 1602 Chestnut Street, Philadelphia.

— The American Society for the Extension of University Teaching proposes to hold, during the holidays, a conference of the leading college men of the country, to consider the subject of university extension from a college point of view. This confer-

ence ought to result in broader views of the relation of the university to university extension.

— University extension has attracted much attention in France. The ministry of education has appointed a committee to investigate the workings of the movement in England, and delegates of the French government were present at the Oxford summer meeting.

— Rev. W. Hudson Shaw, M.A., one of the most popular of the Oxford university extension lecturers, has been engaged by the American Society for the extension of University Teaching for the entire winter of 1892–3.

— The effort of the American Society for the Extension of University Teaching to establish the system of graded work in the Philadelphia centres is meeting with strong success. The West Philadelphia centre has agreed to follow courses of twenty-four weeks each, in literature, history, and science. Wagner Institute plans two such courses in literature and American history. In urging this graded work upon the centres, the popular idea is not lost sight of, but is united with that of consecutive, well-graded study.

— The University of Wisconsin offers for the coming winter university extension lectures on "The Colonization of North America," by Professor Turner; "English Literature," by Professor Freeman; "Scandinavian Literature," by Professor Olsen; "Antiquities of India and Iran," by Dr. Tolman; "Bacteriology," by Professor Birge; "The Physiology of Plants," by Professor Barnes; "Electricity," by Dr. Loomis; and "Geology," by Professor Salisbury. Courses in other departments will be given if any desire for them is expressed. According to the regulations adopted by the board of regents, courses can be given only where the lecturers can go and return without interfering with their class-room duties; but if the success of the proposed courses warrants it, lecturers who can give their entire time to the work will probably be provided.

— Cincinnati has begun the work of university extension with great enthusiasm and zeal. Classes in history, chemistry, and Latin have already begun. Biology, analytics, and trigonometry are proposed for a later course.

— Rhode Island is a conservative state, but when it makes up its mind to change, it enters upon the proposed work with earnestness and vigor. Brown University has already successfully inaugurated university extension in the State. The promptness with which the various towns follow its lead is only a new example of the power which the universities possess for developing and moulding the educational interests of the State. Mount Pleasant, one of the suburbs of Providence, has just formed a new extension centre, with lectures on English history, by President Andrews of Brown University. Professor Wilfred H. Munro, director of university extension for Brown University, has been invited to explain the movement and help in the organization of a centre at Newport. The teachers of Providence are also interested, and plans for several classes under university professors are being discussed.

— The Trenton, N.J., university extension centre offers four courses of six lectures each, in place of the single course given last year. This indicates strong and healthy growth. The first course will be from Oct. 16 to Nov. 10, upon "The Plays of Shakespeare," by Dr. Murray, dean of Princeton College; the second, "Historical Geology," from Nov. 17 to Dec. 22, by Professor W. B. Scott of Princeton; the third, "Political Economy," from Jan. 12 to Feb. 16, by Professor Robert Ellis Thompson of the University of Pennsylvania; and the fourth, illustrated lectures on "Light and Color," from Feb 23 to March 29, by Professor Goodspeed of the University of Pennsylvania. Besides furnishing these twenty-four lectures for three dollars, the Trenton centre offers a supplementary course without charge, if, as is quite probable, the funds received warrant it.

— Topeka, Kan., is to have a university extension course of twelve lectures on electricity, by Professor Blake of the University of Kansas.

— Kansas City has organized a society of university extension, with Hon. Edward H. Allen, president; Professor John T. Buchannan, vice-president; J. F. Downing, treasurer; and John Sullivan, secretary. At the meeting when the organization was effected, short addresses were made by Professor Blackmar of Kansas University, and by Dr. S. S. Lows of Kansas City, ex-president of Missouri University. Professor Blackmar stated that Kansas University would offer eighteen different courses to the people of Kansas City.

— Among the encouraging signs of the times we observe that the colleges open with full classes, and, usually, large accessions. Harvard, Yale, and the Massachusetts Institute of Technology, in New England, the University of Michigan, and all the State universities of the West, as well as Columbia, Princeton, and Lehigh, nearer our own doors, all report crowded classes. Our own State university — Cornell — is just heard from, the accounts of the registration having only just been made up, owing to the rush of business in the registrar's office. The Ithaca *Journal* gives us the following for Oct. 15: freshmen, 431; sophomores, 327; juniors, 221; seniors, 186; graduate students, 126; total, 1,491. The *Journal* of the 17th states that accessions for the week carry the total above 1,500; while the increase for the year, dating back to Oct. 15, 1890, is about 225, or 15 per cent. The increase, curiously enough, is mainly in the two extremes, arts and engineering; the other courses remaining about stationary. Candidates for B A. number 140, for C.E. and M.E. about 650. The university is about equally divided between the literary, the so-called liberal, departments and courses, and the scientific and engineering. Sibley College enrolls just one-third of the students in the university, having 481 undergraduates, of whom 193 are regular freshmen; while its proportion of the graduate students and its "specials," of whom we are told there are usually about a dozen, makes its enrolment somewhere about 525 in all. The number of graduates, principally coming from other colleges, has trebled in the year. The university is greatly embarrassed, notwithstanding its great endowment, by the continual demands for new buildings, which must be paid for out of the income.

— In a recent number of *Petermann's Mitteilungen* Dr. F. Krümmel states the results of his investigations of the Sargasso Sea, a summary of which is given in the Proceedings of the Royal Geographical Society for October. He differs entirely from Humboldt as to the shape of the floating mass of vegetation. The "great bank of Flores and Corvo" is, he says, Humboldt's summing up of the observations made by sailing-vessels passing through the Sargasso Sea on their way from the southern hemispere to Europe. These followed with slight variations the same course, and their observations were naturally limited in extent. It was on these insufficient data that Humboldt founded his theories as to the size and shape of the Sargasso Sea, but now, by the aid of steam, we are able to arrive at more correct conclusions on these points. On a map which he has prepared, Dr. Krümmel has plotted out the general contour of the mass of floating vegetation, and has indicated in what parts of the sea the sargasso is found in the greatest abundance. In shape the Sargasso Sea is a sort of ellipse, the great axis of which almost coincides with the Tropic of Cancer, while the two foci are near longitude 45° and 70° west. Around this central ellipse others are indicated, larger in size, but with the vegetation much less dense. In their general outlines they follow with sufficient nearness the course of the prevailing winds. As to the origin of the algæ, Dr. Krümmel is strongly of the opinion that they come from the land — not only from the Gulf of Mexico and the coast of Florida, but from the shores of the Antilles and the Bahamas. The most recent studies with regard to the origin and course of the Gulf Stream tend, he thinks, strongly to support those who assert that the algæ come from the land, and to disprove the contention of those who support the hypothesis of a marine origin. Now that it is settled that the Gulf Stream is not a single narrow stream issuing from the Gulf of Mexico, but an accumulation of converging currents sweeping past the coasts of the Antilles and through the adjoining seas, it is obvious that the quantity of algæ carried away must be much greater than it could have been were the old hypotheses of

the origin of the Gulf Stream correct. Dr. Krümmel makes an approximate calculation as to the time occupied by the algæ in reaching the Sargasso Sea. A fortnight after reaching the Gulf proper, the weed would, at the rate of two knots an hour, reach the latitude of Cape Hatteras. From that point its onward motion is slower, and it takes about five months and a half for it to reach west of the Azores. After reaching the Sargasso Sea the weed continues to move slowly, until, becoming heavier as it grows older, it gradually sinks to make way for fresh supplies.

— There will be an examination at the Civil Service Commission on Nov. 3 to secure two computers for the Nautical Almanac Office. The salary of one will be $1,000 and the salary of the other will be from $1.000 to $1,400, to be determined after examination. The subjects will be algebra, geometry, trigonometry, logarithms, and astronomy. Application blanks can be obtained of the commission. District applicants will not be admitted. Arrangements may possibly be made for examining applicants at prominent cities outside of Washington if applications are filed in time.

— Mr. J. C. Russell, who has been engaged in exploring the Mount St. Elias region of Alaska, has been heard from at Yakutat. He was not successful in reaching the top of the mountain, but he attained a greater elevation than the height of the mountain as reported by him last year, between 14,000 and 15,000 feet, and there were still some four thousand feet to climb to reach the summit. This places the height of the peak between 18,000 and 19,000 feet, and restores St. Elias to its former position of one of the highest mountains on the continent. La Perouse, in 1876, placed its elevation at 12,672 feet, and it has varied from this all the way to 19,500 feet, as given by Dall in 1874.

— The long talked-of expedition from Australia to the south polar lands has now assumed the title of a "Swedish-Australasian Expedition," and is likely soon to be equipped and dispatched. At a meeting held in Melbourne on the 3d of July last, according to the October Proceedings of the Royal Geographical Society, the report of the Antarctic Exploration Committee was read, in which it was stated that a grant of £1,000 had been proposed by the Queensland government, another of £1,366 on condition that the public subscribed £634, by the New South Wales government, and a third of £300 by the government of Tasmania. It remained to be seen what sum the ministry of Victoria would place upon the estimates. Added to the Swedish donation of £5,000, and a similar sum from Sir Thomas Elder, there remained a balance of £2,000 only to be subscribed and insure the success of the expedition, for the successful carrying out of which Baron Nordenskiöld had stated that £15,000 would be sufficient. At the recent International Congress at Berne a resolution of approval of the proposed expedition and hearty wishes for its success was passed on the reading of a paper on the subject by Admiral Sir Erasmus Ommanney. As a pioneer expedition the project is likely to accomplish most useful work, and its promotion, in face of many obstacles, is highly honorable to the public spirit of the Australian colonies.

— I once heard of a boy who had a pet seal given to him when it was quite young, says a writer in the *Illustrated American*. It became very tame, and used to cuddle up beside the dogs to sleep in front of the fire, and learned to perform very many tricks. One winter the storms were very severe, and the fishermen were at times quite unable to venture to sea to set their nets. As a matter of course fish were scarce, and the seal's food having been of fish alone, milk had to be substituted; but it consumed such vast quantities of the latter that, for purposes of economy, after a family council, it was decided to dispose of the beloved pet as soon as possible. The boy and a clergyman friend, who had always taken a lively interest in the pet, started off in a boat with their precious victim, and, when far enough out for safety, threw the seal into the water. Little did they expect the result, for the creature, feeling itself very much abused, rushed after the boat with all its might and main, uttering such tearful and heart-rending cries of grief that it was at last taken back into the boat, where it lay exhausted, sobbing and wailing like a child. When the familiar home was reached it soon regained its former gaiety and health, and lived to a good old age, little the worse for its adventure.

According to *Nature*, Mr. W. H. Harris of Ealing, England, records in *Nature Notes* (Sept. 15) a remarkable instance of "frugality" in bees. The recent extremely rainy weather seems to have suggested to his bees that there would probably soon be an end of honey-making. Accordingly, although there was "a crate of fairly filled sections above the stock-box," they adopted vigorous measures to prevent future inconvenience. "It is a positive fact," says Mr. Harris, "that my bees, not content with ejecting larvæ of both drones and workers, proceeded to suck out the soft contents of the corpses, leaving only the white chitinous covering, which had not hardened sufficiently to prevent the workers from piercing it with their mandibles, and then inserting their tongues."

— Mr. W. Prentis of Rainham, England, describes in the October number of the *Zoologist* an interesting case of a wild duck's forethought. As quoted in *Nature*, a mowing machine was set to work round the outside of a field of lucerne bordering a marsh, diminishing the circle each time round the field, leaving about two acres in the centre. A wild duck was seen by the shepherd to fly from the piece of lucerne that was left with something in her beak, and, happening to fly near him, she dropped a three-parts incubated egg. She was again observed by the shepherd, and also by the sheep-shearer, carrying another egg in her beak, this time over the marsh-wall towards the saltings; and again she was seen for the third time carrying an egg in her beak in the same direction. Next day, when the field was finished by the removal of the last piece of lucerne, the wild duck's nest from which the eggs had been removed was discovered.

— Carl Lumholtz (author of "Among Cannibals"), who is the head of the expedition now making explorations in the Sierra Madre of Mexico, under the auspices of the American Geographical Society and the Museum of Natural History of New York, will write exclusively for *Scribner's Magazine* the results of his investigations and adventures. The first paper will appear in the November issue. Dr. Lumholtz says: "My intention is to investigate accurately the language, habits, and customs of the primitive people of the Sierra Madre by living with them, as I did with the natives of Australia; and thus I may hope to do my share in the noble work of elucidating the history of the native race of this great continent."

— The Imperial Academy of Sciences, Vienna, has just published in its Memoirs (Vol. XXXIX., Part First) a posthumous work of the traveller Dr. J. J. von Tschudi, which is of uncommon interest to ethnographers and linguists. Its title is "Culturhistorische und sprachliche Beiträge zur Kenntniss des alten Perú" (Wien, F. Tempsky, 1881, pp. 220. 4°). The contents are arranged under thirty eight headings having Indian names, and to give an idea of these, some of those more generally known may be mentioned here: Amaúta, Apatchita, Ketchua, Korikantsa, Llama, Papa, Pariana, Patchakamak, Sairi, Tawantin-suyu, Waka, Waskar (usually spelled *huaca*, *huaskar*), Wirakotcha. In the article "Ketchua" he gives his reasons for defending Clements Markham's opinion, that there had never been an Aimará people, but that the language called Aimará was really that of the Kola'o, or, as we will call them now, Collas. This people was of a sturdy, ferocious race of mountaineers, which resisted for many years the attempts at subjugation made by the Inca "kings." When they had been conquered, the kings colonized other provinces with Kola'o men, who were forced to emigrate, and placed colonists in the Kola'o country, who were taken from Ketchua-speaking populations of the province Aimará. Thus a mixed people was formed, and a new medley language originated among it, which we know under the name of Aimará. In this medley language the elements of the Kola'o are still recognizable from those of the intrusive Ketchua, and prove to be of another linguistic family. Markham's idea of its origin has been also upheld and further developed by Tschudi in his excellent book "Organismus der Ketchua-Sprache" (1884).

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada..... $3.50 a year.

Great Britain and Europe..... 4.50 a year.

Communications will be welcomed from any quarter. Abstracts of scientific papers are solicited, and one hundred copies of the issue containing such will be mailed the author on request in advance. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

CELESTIAL PHYSICS.[1]

(Continued from p. 215.)

THE spectra of the stars are almost infinitely diversified, yet they can be arranged, with some exceptions, in a series in which the adjacent spectra, especially in the photographic region, are scarcely distinguishable, passing from the bluish-white stars like Sirius, through stars more or less solar in character, to stars with banded spectra, which divide themselves into two apparently independent groups, according as the stronger edge of the bands is towards the red or the blue. In such an arrangement the sun's place is towards the middle of the series.

At present a difference of opinion exists as to the direction in the series in which evolution is proceeding, whether by further condensation white stars pass into the orange and red stages, or whether these more colored stars are younger and will become white by increasing age. The latter view was suggested by Johnstone Stoney in 1867.

About ten years ago Ritter, in a series of papers, discussed the behavior of gaseous masses during condensation, and the probable resulting constitution of the heavenly bodies. According to him, a star passes through the orange and red stages twice; first during a comparatively short period of increasing temperature, which culminates in the white stage, and a second time during a more prolonged stage of gradual cooling. He suggested that the two groups of banded stars may correspond to these different periods, the young stars being those in which the stronger edge of the dark band is towards the blue, the other banded stars, which are relatively less luminous and few in number, being those which are approaching extinction through age.

Recently a similar evolutional order has been suggested, which is based upon the hypothesis that the nebulæ and stars consist of colliding meteoric stones in different stages of condensation.

[1] Inaugural address at the meeting of the British Association for the Advancement of Science, at Cardiff, August, 1891, by William Huggins, president of the association (Nature, Aug. 20).

More recently the view has been put forward that the diversified spectra of the stars do not represent the stages of an evolutional progress, but are due for the most part to differences of original constitution.

The few minutes which can be given to this part of the address are insufficient for a discussion of these different views. I purpose, therefore, to state briefly, and with reserve, as the subject is obscure, some of the considerations from the characters of their spectra which appeared to me to be in favor of the evolutional order in which I arranged the stars from their photographic spectra in 1879. This order is essentially the same as Vogel had previously proposed in his classification of the stars in 1874, in which the white stars, which are most numerous, represent the early adult and most persistent stage of stellar life, the solar condition that of full maturity and of commencing age, while in the orange and red stars with banded spectra we see the setting in and advance of old age. But this statement must be taken broadly, and not as asserting that all stars, however different in mass and possibly to some small extent in original constitution, exhibit one invariable succession of spectra.

In the spectra of the white stars the dark metallic lines are relatively inconspicuous, and occasionally absent, at the same time that the dark lines of hydrogen are usually strong, and more or less broad, upon a continuous spectrum, which is remarkable for its brilliancy at the blue end. In some of these stars the hydrogen and some other lines are bright, and sometimes variable.

As the greater or less prominence of the hydrogen lines, dark or bright, is characteristic of the white stars as a class, and diminishes gradually with the incoming and increase in strength of the other lines, we are probably justified in regarding it as due to some conditions which occur naturally during the progress of stellar life, and not to a peculiarity of original constitution.

To produce a strong absorption-spectrum a substance must be at the particular temperature at which it is notably absorptive; and, further, this temperature must be sufficiently below that of the region behind from which the light comes for the gas to appear, so far as its special rays are concerned, as darkness upon it. Considering the high temperature to which hydrogen must be raised before it can show its characteristic emission and absorption, we shall probably be right in attributing the relative feebleness or absence of the other lines, not to the paucity of the metallic vapors, but rather to their being so hot relatively to the substances behind them as to show feebly, if at all, by reversion. Such a state of things would more probably be found, it seems to me, in conditions anterior to the solar stage. A considerable cooling of the sun would probably give rise to banded spectra due to compounds, or to more complex molecules, which might form near the condensing points of the vapors.

The sun and stars are generally regarded as consisting of glowing vapors surrounded by a photosphere where condensation is taking place, the temperature of the photospheric layer from which the greater part of the radiation comes being constantly renewed from the hotter matter within.

At the surface the convection currents would be strong, producing a considerable commotion, by which the different gases would be mixed and not allowed to retain the inequality of proportions at different levels due to their vapor densities.

Now the conditions of the radiating photosphere and those of the gases above it, on which the character of the spectrum of a star depends, will be determined, not alone by tempera-

ture, but also by the force of gravity in these regions: this force will be fixed by the star's mass and its stage of condensation, and will become greater as the star continues to condense.

In the case of the sun the force of gravity has already become so great at the surface that the decrease of the density of the gases must be extremely rapid, passing in the space of a few miles from atmospheric pressure to a density infinitesimally small; consequently the temperature-gradient at the surface, if determined solely by expansion, must be extremely rapid. The gases here, however, are exposed to the fierce radiation of the sun, and unless wholly transparent would take up heat, especially if any solid or liquid particles were present from condensation or convection currents.

From these causes, within a very small extent of space at the surface of the sun, all bodies with which we are acquainted should fall to a condition in which the extremely tenuous gas could no longer give a visible spectrum. The insignificance of the angle subtended by this space as seen from the earth should cause the boundary of the solar atmosphere to appear defined. If the boundary which we see be that of the sun proper, the matter above it will have to be regarded as in an essentially dynamical condition — an assemblage, so to speak, of gaseous projectiles for the most part falling back upon the sun after a greater or less range of flight. But in any case it is within a space of relatively small extent in the sun, and probably in the other solar stars, that the reversion which is manifested by dark lines is to be regarded as taking place.

Passing backward in the star's life, we should find a gradual weakening of gravity at the surface, a reduction of the temperature-gradient so far as it was determined by expansion, and convection currents of less violence producing less interference with the proportional quantities of gases due to their vapor densities, while the effects of eruptions would be more extensive.

At last we might come to a state of things in which, if the star were hot enough, only hydrogen might be sufficiently cool relatively to the radiation behind to produce a strong absorption. The lower vapors would be protected, and might continue to be relatively too hot for their lines to appear very dark upon the continuous spectrum; besides, their lines might be possibly to some extent effaced by the coming in under such conditions in the vapors themselves of a continuous spectrum.

In such a star the light radiated towards the upper part of the atmosphere may have come from portions lower down of the atmosphere itself, or at least from parts not greatly hotter. There may be no such great difference of temperature of the low and less low portions of the star's atmosphere as to make the darkening effect of absorption of the protected metallic vapors to prevail over the illuminating effect of their emission.

It is only by a vibratory motion corresponding to a very high temperature that the bright lines of the first spectrum of hydrogen can be brought out, and by the equivalence of absorbing and emitting power that the corresponding spectrum of absorption should be produced; yet for a strong absorption to show itself, the hydrogen must be cool relatively to the source of radiation behind it, whether this be condensed particles or gas. Such conditions, it seems to me, should occur in the earlier rather than in the more advanced stages of condensation.

The subject is obscure, and we may go wrong in our mode of conceiving of the probable progress of events, but there can be no doubt that in one remarkable instance the white-star spectrum is associated with an early stage of condensation.

Sirius is one of the most conspicuous examples of one type of this class of stars. Photometric observations combined with its ascertained parallax show that this star emits from forty to sixty times the light of our sun, even to the eye, which is insensible to ultra-violet light, in which Sirius is very rich, while we learn from the motion of its companion that its mass is not much more than double that of our sun. It follows that, unless we attribute to this star an improbably great emissive power, it must be of immense size, and in a much more diffuse and therefore an earlier condition than our sun; though probably at a later stage than those white stars in which the hydrogen lines are bright.

A direct determination of the relative temperature of the photospheres of the stars might possibly be obtained in some cases from the relative position of maximum radiation of their continuous spectra. Langley has shown that through the whole range of temperature on which we can experiment, and presumably at temperatures beyond, the maximum of radiation-power in solid bodies gradually shifts upwards in the spectrum from the infra red through the red and orange, and that in the sun it has reached the blue.

The defined character, as a rule, of the stellar lines of absorption suggests that the vapors producing them do not at the same time exert any strong power of general absorption. Consequently, we should probably not go far wrong, when the photosphere consists of liquid or solid particles, if we could compare select parts of the continuous spectrum between the stronger lines, or where they are fewest. It is obvious that, if extended portions of different stellar spectra were compared, their true relation would be obscured by the line-absorption.

The increase of temperature, as shown by the rise in the spectrum of the maximum of radiation, may not always be accompanied by a corresponding greater brightness of a star as estimated by the eye, which is an extremely imperfect photometric instrument. Not only is the eye blind to large regions of radiation, but even for the small range of light that we can see the visual effect varies enormously with its color. According to Professor Langley, the same amount of energy which just enables us to perceive light in the crimson at A would in the green produce a visual effect 100,000 times greater. In the violet the proportional effect would be 1,600, in the blue 62,000, in the yellow 28,000, in the orange 14,000, and in the red 1,200. Captain Abney's recent experiments make the sensitiveness of the eye for the green near F to be 750 times greater than for the red about C. It is for this reason, at least in part, that I suggested in 1864, and have since shown by direct observation, that the spectrum of the nebula in Andromeda, and presumably of similar nebulæ, is, in appearance, only wanting in the red.

The stage at which the maximum radiation is in the green, corresponding to the eye's greatest sensitiveness, would be that in which it could be most favorably measured by eye-photometry. As the maximum rose into the violet and beyond, the star would increase in visual brightness, but not in proportion to the increase of energy radiated by it.

The brightness of a star would be affected by the nature of the substance by which the light was chiefly emitted. In the laboratory, solid carbon exhibits the highest emissive power. A stellar stage in which radiation comes, to a large extent, from a photosphere of the solid particles of this sub-

stance, would be favorable for great brilliancy. Though the stars are built up of matter essentially similar to that of the sun, it does not follow that the proportion of the different elements is everywhere the same. It may be that the substances condensed in the photospheres of different stars may differ in their emissive powers, but probably not to a great extent.

All the heavenly bodies are seen by us through the tinted medium of our atmosphere. According to Langley, the solar stage of stars is not really yellow, but, even as gauged by our imperfect eyes, would appear bluish-white if we could free ourselves from the deceptive influence of our surroundings.

From these considerations it follows that we can scarcely infer the evolutional stages of the stars from a simple comparison of their eye-magnitudes. We should expect the white stars to be, as a class, less dense than the stars in the solar stage. As great mass might bring in the solar type of spectrum at a relatively earlier time, some of the brightest of these stars may be very massive, and brighter than the sun — for example, the brilliant star Arcturus. For these reasons the solar stars should not only be denser than the white stars, but perhaps, as a class, surpass them in mass and eye-brightness.

It has been shown by Lane that, so long as a condensing gaseous mass remains subject to the laws of a purely gaseous body, its temperature will continue to rise.

The greater or less breadth of the lines of absorption of hydrogen in the white stars may be due to variations of the depth of the hydrogen in the line of sight, arising from the causes which have been discussed. At the sides of the lines the absorption and emission are feebler than in the middle, and would come out more strongly with a greater thickness of gas.

The diversities among the white stars are nearly as numerous as the individuals of the class. Time does not permit me to do more than record that, in addition to the three sub-classes into which they have been divided by Vogel, Scheiner has recently investigated minor differences as suggested by the character of the third line of hydrogen near G. He has pointed out, too, that so far as his observations go the white stars in the constellation of Orion stand alone, with the exception of Algol, in possessing a dark line in the blue which has apparently the same position as a bright line in the great nebula of the same constellation; and Pickering finds in his photographs of the spectra of these stars dark lines corresponding to the principal lines of the bright-line stars, and the planetary nebulæ with the exception of the chief nebular lines. The association of white stars with nebular matter in Orion, in the Pleiades, in the region of the Milky Way, and in other parts of the heavens, may be regarded as falling in with the view that I have taken.

In the stars possibly further removed from the white class than our sun, belonging to the first division of Vogel's third class, which are distinguished by absorption bands with their stronger edge towards the blue, the hydrogen lines are narrower than in the solar spectrum. In these stars the density-gradient is probably still more rapid, the depths of hydrogen may be less, and possibly the hydrogen molecules may be affected by a larger number of encounters with dissimilar molecules. In some red stars with dark hydrocarbon bands, the hydrogen lines have not been certainly observed; if they are really absent, it may be because the temperature has fallen below the point at which hydrogen can exert its characteristic absorption; besides, some hydrogen will have united with the carbon. The coming in of the hydrocarbon bands may indicate a later evolutional stage, but the temperature may still be high, as acetylene can exist in the electric arc.

A number of small stars more or less similar to those which are known by the names of their discoverers, Wolf and Rayet, have been found by Pickering in his photographs. These are remarkable for several brilliant groups of bright lines, including frequently the hydrogen lines and the line D_3, upon a continuous spectrum strong in blue and violet rays, in which are also dark lines of absorption. As some of the bright groups appear in his photographs to agree in position with corresponding bright lines in the planetary nebulæ, Pickering suggests that these stars should be placed in one class with them, but the brightest nebular line is absent from these stars. The simplest conception of their nature would be that each star is surrounded by a nebula, the bright groups being due to the gaseous matter outside the star. Mr. Roberts, however, has not been able to bring out any indication of nebulosity by prolonged exposure. The remarkable star η Argus may belong to this class of the heavenly bodies.

In the nebulæ, the elder Herschel saw portions of the fiery mist or "shining fluid" out of which the heavens and the earth had been slowly fashioned. For a time this view of the nebulæ gave place to that which regarded them as external galaxies, cosmical "sand-heaps," too remote to be resolved into separate stars; though indeed, in 1858, Mr. Herbert Spencer showed that the observations of nebulæ up to that time were really in favor of an evolutional progress.

In 1864 I brought the spectroscope to bear upon them: the bright lines which flashed upon the eye showed the source of the light to be glowing gas, and so restored these bodies to what is probably their true place, as an early stage of sidereal life.

At that early time our knowledge of stellar spectra was small. For this reason partly, and probably also under the undue influence of theological opinions then widely prevalent, I unwisely wrote in my original paper in 1864, "that in these objects we no longer have to do with a special modification of our own type of sun, but find ourselves in presence of objects possessing a distinct and peculiar plan of structure." Two years later, however, in a lecture before this association, I took a truer position. "Our views of the universe," I said, "are undergoing important changes: let us wait for more facts, with minds unfettered by any dogmatic theory, and therefore free to receive their teaching, whatever it may be, of new observations."

Let us turn aside for a moment from the nebulæ in the sky to the conclusions to which philosophers had been irresistibly led by a consideration of the features of the solar system. We have before us in the sun and planets obviously not a haphazard aggregation of bodies, but a system resting upon a multitude of relations pointing to a common physical cause. From these considerations Kant and Laplace formulated the nebular hypothesis, resting it on gravitation alone, for at that time the science of the conservation of energy was practically unknown. These philosophers showed how, on the supposition that the space now occupied by the solar system was once filled by a vaporous mass, the formation of the sun and planets could be reasonably accounted for.

By a totally different method of reasoning, modern science traces the solar system backward step by step to a similar state of things at the beginning. According to Helmholtz, the sun's heat is maintained by the contraction of his mass,

at the rate of about 220 feet a year. Whether at the present time the sun is getting hotter or colder we do not certainly know. We can reason back to the time when the sun was sufficiently expanded to fill the whole space occupied by the solar system, and was reduced to a great glowing nebula. Though man's life, the life of the race perhaps, is too short to give us direct evidence of any distinct stages of so august a process, still the probability is great that the nebular hypothesis, especially in the more precise form given to it by Roche, does represent broadly, notwithstanding some difficulties, the succession of events through which the sun and planets have passed.

The nebular hypothesis of Laplace requires a rotating mass of fluid which at successive epochs became unstable from excess of motion, and left behind rings, or more probably perhaps lumps, of matter from the equatorial regions.

The difficulties to which I have referred have suggested to some thinkers a different view of things, according to which it is not necessary to suppose that one part of the system gravitationally supports another. The whole may consist of a congeries of discrete bodies, even if these bodies be the ultimate molecules of matter. The planets may have been formed by the gradual accretion of such discrete bodies. On the view that the material of the condensing solar system consisted of separate particles or masses, we have no longer the fluid pressure which is an essential part of Laplace's theory. Faye, in his theory of evolution from meteorites, has to throw over this fundamental idea of the nebular hypothesis, and he formulates instead a different succession of events, in which the outer planets were formed last, a theory which has difficulties of its own.

Professor George Darwin has recently shown, from an investigation of the mechanical conditions of a swarm of meteorites, that on certain assumptions a meteoric swarm might behave as a coarse gas, and in this way bring back the fluid pressure exercised by one part of the system on the other, which is required by Laplace's theory. One chief assumption consists in supposing that such inelastic bodies as meteoric stones might attain the effective elasticity of a high order which is necessary to the theory through the sudden volatilization of a part of their mass at an encounter, by which what is virtually a violent explosive is introduced between the two colliding stones. Professor Darwin is careful to point out that it must necessarily be obscure as to how a small mass of solid matter can take up a very large amount of energy in a small fraction of a second.

Any direct indications from the heavens themselves, however slight, are of so great value, that I should perhaps in this connection call attention to a recent remarkable photograph, by Mr. Roberts, of the great nebula in Andromeda. On this plate we seem to have presented to us some stage of cosmical evolution on a gigantic scale. The photograph shows a sort of whirlpool disturbance of the luminous matter which is distributed in a plane inclined to the line of sight, in which a series of rings of bright matter separated by dark space, greatly foreshortened by perspective, surround a large undefined central mass. We are ignorant of the parallax of this nebula, but there can be little doubt that we are looking upon a system very remote, and therefore of a magnitude greatly beyond our power of adequate comprehension. The matter of this nebula, in whatever state it may be, appears to be distributed, as in so many other nebulæ, in rings or spiral streams, and to suggest a stage in a succession of evolutional events not inconsistent with that which the nebular hypothesis requires. To liken this object more directly to any particular stage in the formation of the solar system would be "to compare things great with small," and might be indeed to introduce a false analogy; but, on the other hand, we should err through an excess of caution if we did not accept the remarkable features brought to light by this photograph as a presumptive indication of a progress of events in cosmical history following broadly upon the lines of Laplace's theory.

The old view of the original matter of the nebulæ, that it consisted of a "fiery mist,"

> "a tumultuous cloud
> Instinct with fire and nitre,"

fell at once with the rise of the science of thermodynamics. In 1854 Helmholtz showed that the supposition of an original fiery condition of the nebulous stuff was unnecessary, since in the mutual gravitation of widely separated matter we have a store of potential energy sufficient to generate the high temperature of the sun and stars. We can scarcely go wrong in attributing the light of the nebulæ to the conversion of the gravitational energy of shrinkage into molecular motion.

The idea that the light of comets and of nebulæ may be due to a succession of ignited flashes of gas from the encounters of meteoric stones was suggested by Professor Tait, and was brought to the notice of this association in 1871 by Sir William Thomson in his presidential address.

The spectrum of the bright-line nebulæ is certainly not such a spectrum as we should expect from the flashing by collisions of meteorites similar to those which have been analyzed in our laboratories. The strongest lines of the substances which in the case of such meteorites would first show themselves, iron, sodium, magnesium, nickel, etc., are not those which distinguish the nebular spectrum. On the contrary, this spectrum is chiefly remarkable for a few brilliant lines, very narrow and defined, upon a background of a faint continuous spectrum, which contains numerous bright lines, and probably some lines of absorption.

The two most conspicuous lines have not been interpreted, for though the second line falls near, it is not coincident with a strong double line of iron. It is hardly necessary to say that though the near position of the brightest line to the bright double line of nitrogen, as seen in a small spectroscope in 1864, naturally suggested at that early time the possibility of the presence of this element in the nebulæ, I have been careful to point out, to prevent misapprehension, that in more recent years the nitrogen line and subsequently a lead line have been employed by me solely as fiducial points of reference in the spectrum.

The third line we know to be the second line of the first spectrum of hydrogen. Mr. Keeler has seen the first hydrogen spectrum in the red, and photographs show that this hydrogen spectrum is probably present in its complete form, or nearly so, as we first learned to know it in the absorption spectrum of the white stars.

We are not surprised to find associated with it the line D_3, near the position of the absent sodium lines, probably due to the atom of some unknown gas, which in the sun can only show itself in the outbursts of highest temperature, and for this reason does not reveal itself by absorption in the solar spectrum.

It is not unreasonable to assume that the two brightest lines, which are of the same order, are produced by substances of a similar nature, in which a vibratory motion

corresponding to a very high temperature is also necessary. These substances, as well as that represented by the line D_3, may be possibly some of the unknown elements which are wanting in our terrestrial chemistry between hydrogen and lithium, unless indeed D_3 be on the lighter side of hydrogen.

In the laboratory we must have recourse to the electric discharge to bring out the spectrum of hydrogen; but in a vacuum-tube, though the radiation may be great, from the relative fewness of the luminous atoms or molecules or from some other cause, the temperature of the gas as a whole may be low.

On account of the large extent of the nebulæ, a comparatively small number of luminous molecules or atoms would probably be sufficient to make the nebulæ as bright as they appear to us. On such an assumption the average temperature may be low, but the individual particles, which by their encounters are luminous, must have motions corresponding to a very high temperature, and in this sense be extremely hot.

In such diffuse masses, from the great mean length of free path, the encounters would be rare but correspondingly violent, and tend to bring about vibrations of comparatively short period, as appears to be the case if we may judge by the great relative brightness of the more refrangible lines of the nebular spectrum.

Such a view may perhaps reconcile the high temperature which the nebular spectrum undoubtedly suggests with the much lower mean temperature of the gaseous mass, which we should expect at so early a stage of condensation, unless we assume a very enormous mass, or that the matter coming together had previously considerable motion, or considerable molecular agitation.

The inquisitiveness of the human mind does not allow us to remain content with the interpretation of the present state of the cosmical masses, but suggests the question,

> "What see'st thou else
> In the dark backward and abysm of time?"

What was the original state of things? How has it come about that by the side of ageing worlds we have nebulæ in a relatively younger stage? Have any of them received their birth from dark suns, which have collided into new life, and so belong to a second or later generation of the heavenly bodies?

During the short historic period, indeed, there is no record of such an event; still it would seem to be only through the collision of dark suns, of which the number must be increasing, that a temporary rejuvenescence of the heavens is possible, and by such ebbings and flowings of stellar life that the inevitable end to which evolution in its apparently uncompensated progress is carrying us can, even for a little, be delayed

We cannot refuse to admit as possible such an origin for nebulæ.

In considering, however, the formation of the existing nebulæ we must bear in mind that, in the part of the heavens within our ken, the stars still in the early and middle stages of evolution exceed greatly in number those which appear to be in an advanced condition of condensation. Indeed, we find some stars which may be regarded as not far advanced beyond the nebular condition.

It may be that the cosmical bodies which are still nebulous owe their later development to some conditions of the part of space where they occur, such as, conceivably, a greater original homogeneity, in consequence of which condensation began less early. In other parts of space, condensation may have been still further delayed, or even have not yet begun. It is worthy of remark that these nebulæ group themselves about the Milky Way, where we find a preponderance of the white-star type of stars, and almost exclusively the bright-line stars which Pickering associates with the planetary nebulæ. Further, Dr. Gill concludes, from the rapidity with which they impress themselves upon the plate, that the fainter stars of the Milky Way also, to a large extent, belong to this early type of stars. At the same time other types of stars occur also over this region, and the red hydrocarbon stars are found in certain parts; but possibly these stars may be before or behind the Milky Way, and not physically connected with it.

If light matter be suggested by the spectrum of these nebulæ, it may be asked further, as a pure speculation, whether in them we are witnessing possibly a later condensation of the light matter which had been left behind, at least in a relatively greater proportion, after the first growth of worlds into which the heavier matter condensed, though not without some entanglement of the lighter substances. The wide extent and great diffuseness of this bright-line nebulosity over a large part of the constellation of Orion may be regarded perhaps as pointing in this direction. The diffuse nebulous matter streaming round the Pleiades may possibly be another instance, though the character of its spectrum has not yet been ascertained.

In the planetary nebulæ, as a rule, there is a sensible increase of the faint continuous spectrum, as well as a slight thickening of the bright lines towards the centre of the nebula, appearances which are in favor of the view that these bodies are condensing gaseous masses.

Professor George Darwin, in his investigation of the equilibrium of a rotating mass of fluid, found, in accordance with the independent researches of Poincaré, that when a portion of the central body becomes detached through increasing angular velocity, the portion should bear a far larger ratio to the remainder than is observed in the planets and satellites of the solar system, even taking into account he terogeneity from the condensation of the parent mass.

Now this state of things, in which the masses, though not equal, are of the same order, does seem to prevail in many nebulæ, and to have given birth to a large number of binary stars. Mr. See has recently investigated the evolution of bodies of this class, and points out their radical differences from the solar system in the relatively large mass-ratios of the component bodies, as well as in the high eccentricities of their orbits brought about by tidal friction, which would play a more important part in the evolution of such systems.

Considering the large number of these bodies, he suggests that the solar system should perhaps no longer be regarded as representing celestial evolution in its normal form —

> "A goodly Paterne to whose perfect mould
> He fashioned them . . ."—

but rather as modified by conditions which are exceptional.

It may well be that in the very early stages condensing masses are subject to very different conditions, and that condensation may not always begin at one or two centres, but sometimes set in at a large number of points, and proceed in the different cases along very different lines of evolution.

(To be continued.)

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Solar Diffraction Glow.

A FAINT yet clearly perceptible diffraction ring has appeared around the sun for about a week past. It had a pale purplish tint, and at the outer margin faded into the blue sky by almost imperceptible degrees. The centre was tinted nearly to the sun, and was not so bright and white as was the case in Bishop's ring in 1883–85. The part of the ring at 22½ degrees from the sun was little if any brighter than the parts adjacent. The outer margin of the ring reached to 30 degrees, and some days perhaps to 35 degrees. The storms of late September and first days of October cleared away and left the deep blue sky without a cloud or even haze. The colored ring could not be definitely recognized till about noon. After that time it grew brighter till sunset, when the part of the ring which remained above the horizon rapidly changed to a most brilliant violet-purple. The illuminated portion of the sky at sunset was nearly semi-circular and had a greater diameter than the tinted ring of the afternoon, but where the ring had been perceptible during the day, the twilight tints were most intense.

These observations were made in the San Juan Mountains in Colorado, at an altitude of 10,800 feet. I observed Bishop's ring for about two years, and this ring is in several respects different from that. G. H. STONE.

Ironton, Col., Oct. 12.

Rain-Making.

REASONING from well-established meteorological principles alone, I should say that the probabilities of success in rain-making are quite small. But we have learned that it is hazardous to predict confidently, *a priori*, what nature may do under untried conditions. New principles may be discovered which may modify the operation of those already known. As far as I am informed, reports concerning the results of the experiments being made in the South-west are contradictory. And if rain does follow a few explosions there at this season of the year, when rains occur in most portions of the temperate zones, would that settle the question without dispute?

It seems to me that the effects following great battles have not been recorded with sufficient care to furnish reliable data. When the air in any region is nearly saturated with moisture, it is reasonable to suppose that a violent disturbance in the atmosphere may cause a sufficient condensation to produce rain. But when it is far below saturation, it seems to me that the results must be doubtful until fully established by experiment. Let the experiments be made in places where it seldom or never rains — for instance, in the Sahara. A series of such experiments would determine the question without doubt. I await results with great interest. MARSHALL HENSHAW.

Amherst, Mass, Oct. 14.

AMONG THE PUBLISHERS.

A BOOK has just been published entitled "The Business of Travel," a fifty years' record of progress, by Fraser Rae, giving in detail an account of the origin and growth of the now marvellously developed organization of Thomas Cook & Son. To scores of thousands who have made pilgrimages to the Meccas of the world as excursionists, guided, directed, and conserved in all interests by this concern, this book, which is packed with information as to travel in this country, in Europe, and in Eastern lands, will be found not only entertaining but instructive.

— The *Publishers' Weekly* says, that, in response to an inquiry, the Assistant Secretary of the Treasury writes the following, which will be of interest to all bookbuyers: "In reply to your letter in which you inquire if you can purchase books in England and have them sent to you by mail, I have to inform you that the importation of dutiable articles, which includes dutiable books, is forbidden by Article XI. of the Universal Postal Union Convention, and books so imported are subject to seizure. Books printed exclusively in languages other than English, and various other books, are exempt from duty under certain provisions of the Free List, Act of Oct. 1, 1890, and such books are not included in the prohibition.

— John Wiley & Sons have in preparation a "Manual of Mining," by Professor M. C. Ihlseng.

— There has been no book written on Hawaii, or the Sandwich Islands, as many still call them, within the last twenty years. But this silence will soon be broken by Mrs. Helen Mather, who has written an account of "One Summer in Hawaii," which the Cassell Publishing Company will publish. Mrs. Mather's book will undoubtedly turn the attention of many travellers toward this little group of islands in the Pacific. It will be illustrated from photographs and drawings made by Walter McDougall, who has had the pleasure of spending part of the summer in Hawaii.

— Miss Isabel F. Hapgood has translated a large number of Tolstóy's books, and Miss Isabel F. Hapgood has been journeying in Russia. What more natural than that she should see "Count Tolstóy at Home," and what still more natural than that she should make this the title and subject of a paper in the November *Atlantic*. Miss Hapgood, although admiring his great gifts, is not a blind adherent of his changeable philosophies. Here is a bit of useful information: the name Tolstóy with the *y* is the writer's own way of spelling his own name, and not a typographical error.

— Little, Brown, & Co. have just ready the ninth edition of Bartlett's "Familiar Quotations," greatly enlarged, and now representing eight hundred and fifty authors and twelve thousand new lines of index, making the volume one-third larger than the previous edition; and "A Narrative of Events Connected with the Introduction of Sulphuric Ether into Surgical Use," by Richard Manning Hodges, A.M., M.D., formerly of the Massachusetts General Hospital.

— All teachers who are interested in seeing the best masterpieces of literature put before school children in an attractive and inexpensive form will be gratified to learn that Houghton, Mifflin, & Co. have just issued, as No. 51 of their Riverside Literature Series (price, in paper covers, 15 cents), "Rip Van Winkle and other American Essays from Washington Irving's Sketch Book." In addition to "Rip Van Winkle," the book contains the famous "Legend of Sleepy Hollow," "Philip of Pokanoket," introductions and explanatory notes, and a biographical sketch of the author. Early in December, No. 52 of the same series will appear, containing "The Voyage and other English Essays from the Sketch Book."

— The Peruvian traveller and linguist, J. J. von Tschudi, lately deceased, had been successful in collecting almost all the books, pamphlets, and treatises that had ever appeared in the Quichua language, still the most important idiom of that extensive country. Among the few oldest books which he had never been able to see is the grammar of the Dominican priest Domingo de Sancto Thomas, "Arte de la lengua Quichua." The well-known republisher of South American linguistic books, Dr. Julius Platzmann, has been fortunate enough to secure a copy at a pretty steep price, and has now reproduced it in a fac-simile edition, for sale at B. G. Teubner's, Leipzig. It is a neat little sedecimo in small Gothic print, containing a *prologo* and ninety-six leaves (192 pages). Old Indian grammars of those times are fashioned after the model of the Latin language, and this one makes no exception. It was the first grammar of the Quichua language, and evinces an uncommonly thorough study of it. It is dated Valladolid, 1560. The Quichua lexicon of this author is of the same date, and is the first print in which the name "Quichua," which is the name of a Peruvian tribe of the Andahuaylas district, has been applied to this language.

— Messrs. J. B. Lippincott Company announce for early publication the "Life of Benjamin Harris Brewster," by Eugene Coleman Savidge, M.D. Mr. Brewster took an active and important part in many of the most critical and exciting movements in our recent national history. He knew more or less intimately every American celebrity since the time of Webster and Clay, and his

biography will be a valuable contribution to the history of the last half-century of our national life. The second volume of "Hermetic Philosophy," by Styx of the "H. B. of L." will soon be issued by the same publishers. As in the first volume, it includes lessons, general discourses, and explanations of "Fragments" from the schools of Egypt, Chaldea, Greece, Italy, etc., and is a continuation of the line of thought treated in that work. One of the acquisitions to medical literature of the year will be the new edition of Professor Roberts Bartholow's "Hypodermatic Medication," about to be issued from the press of the same company.

— The J. B. Lippincott Company of Philadelphia have published an octavo volume entitled "Harmony of Ancient History," by Malcomb Macdonald. It is an attempt to determine the dates of the best known events in Oriental History and to harmonize the chronology of the Egyptians with that of the Jews. Our knowledge of Egyptian chronology was formerly confined to the statements of the Greek historian Manetho, but we now have the testimony of the Egyptian monuments to aid us; yet the best modern authorities differ by many centuries as to the dates of Egyptian kings. On the other hand, the Bible chronology, besides being sometimes inconsistent with itself, is not in accord with that of Egypt and other nations, and the result is a mass of doubt and confusion. Mr. Macdonald has here endeavored to fix the dates of some Egyptian kings by means of astronomical phenomena recorded on the monuments whose occurrence our modern astronomy enables us to verify. He then proceeds to the Jewish chronology with the avowed purpose of showing that it harmonizes with that of Egypt and Assyria; and he claims for his scheme that "there is not one single chronological statement in the Bible from which it does not remove all improbability." To attain this end, however, he is obliged to resort to some devices and interpretations that seem forced and arbitrary, and he admits that "the whole scheme rests largely on circumstantial evidence." For our part we doubt if any reconciliation of the ancient chronologies is possible, the gaps in the monumental records being so great and other ancient histories so largely mythical as to preclude a satisfactory solution of the problem; but Mr. Macdonald has made an elaborate attempt at such reconciliation, and we leave the criticism of his work to those who have made a special study of the subject.

— The newest of important educational movements, "University Extension," will have first place in the *Popular Science Monthly* for November. The article is by Professor C. Hanford Henderson, and, after sketching what has been done in England, it describes the beginning that has been made in this country, and tells the plans of the extension organizers for the future. In the same number Mr. W. F. Durfee will conclude his contributions to the series of illustrated articles on the development of American industries with a paper on "The Manufacture of Steel." This paper completes the account of the Bessemer process, and proves

that its chief feature was first developed by an American. The same issue will contain an article by Professor Frederick Starr on "Ornament;" one by President Goodale (his address to the American Association for the Advancement of Science) on "Some of the Possibilities of Economic Botany;" and the second of the "Lessons from the Census," by Mr. Carroll D. Wright.

— Bradlee Whidden will publish, about Nov. 15, "Modern American Rifles," by A. C. Gould (Ralph Greenwood), a work which will discuss the merits and capabilities as well as the advancement made in the American rifle.

— The *Chautauquan* for November has several illustrated articles and the portraits of a number of prominent women. The following titles are from the table of contents: "Physical Life," II., by Milton J. Greenman; "National Agencies for Scientific Research," II., by Major J. W. Powell; "The Adulteration of Foods," by Guilford L. Spencer; "Potters and Their Craft," by Thomas B. Preston; "Social Science in the Pulpit," by John Habberton; "People and Places," by Daniel C. Gilman, LL.D.; "Women's Clubs in London," by Elizabeth Robins Pennell; "Among the Creoles," by Mary L. Schaffter; "The Prevention of Crime," by Mrs. Kate Tannatt Woods; "Women as Astronomers" (first paper), by Esther Singleton; and "Cremation," by Anna Churchell Carey.

— D. C. Heath & Co., Boston, will issue in November "Herbert's Allgemeine Pädagogik," translated by Henry M. Felkin of London, and edited, with an introduction, by Oscar Browning, author of "Educational Theories."

— In the November issue of the *New England Magazine*, Walter Blackburn Harte makes a plea for a world without books. He thinks that education is not an unmixed blessing, as the greater the intelligence of individuals and peoples the greater is their capacity for suffering.